KINESTHESIA AND THE INTELLIGENT WILL

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I. INTRODUCTORY

The purpose of this research and essay is to point out in terms of more or less well-known nerve-circuits a new consideration or two as to the nature of human motivation and will. In the chosen title the term intelligent is used, therefore, in a very broad sense to include several processes other than intelligence in the technical psychological usage, particularly affective tone. A more precise expression than intelligent will would be perhaps teleologic conation, however cumbersome such a term may be. Both, however, seem to the writer to express definitely enough the empirical motivation-tendency of the actual human adult.

Just as, psychologically considered, vision is undoubtedly the "queen" of the senses, so physiologically the processes inherently relating to movement, posture, weight, spatiality, etc., are assuredly the most important. In the universal integration of sensations, vision in a way may even be considered the mental homologue of the bodily kinesthesia as a little thought readily shows. Only now are educators beginning to realize the indispensable usefulness always and everywhere of kinesthesia, the "feelings of movement." Kinesthesia is about, however, to come into its own as the primary and essential sense. Without it, coördinated and adapted bodily movement and strain, concomitant to every kind of mental

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process, is inconceivable, for the (psycho) motor centers in the brain have no known clairvoyant powers and therefore their function of carefully coördinating the distant muscles, *e. g.,* of foot or hand, is entirely dependent on their continual reception of detailed information as to the relative tonal and contractural status of all the active parts to one another. Simple as this idea is, the immense practical importance for education has as yet hardly begun to seep into the effective minds of educators. Its relation in a general way to voluntary movement has recently been set forth inadequately in an article (17) by the present writer from which the following quotation may be expedient.

"The *nervous circuits* which underlie voluntary movement are really of course the functional framework, so to say, of all neuro-musculo-glandular activity. The idea is the modern successor of the reflex arc, the succession being made necessary by our increased knowledge of the nature and uses of kinesthesia. Here again our classification is arbitrary to some extent, but none the less useful, perhaps, for descriptive purposes, and withal tentative.

The simplest "circuit" that we have to consider is that which we may call intramuscular. The knee jerk, for example, is far too quick to be a spinal reflex, so that we have to suppose it a direct reaction from the thick subpatellar tendon of the muscle-mass concerned, a direct stimulation of the elastic muscle-fibers. It is obviously only for the sake of logical completeness that we start with this, for a literal circuit here is hard to define, and moreover useless for our present purpose.

The next type of circuit is similar to the vegetative circuits of the sympathetic system, such for example as are concerned in the movements of the intestines, by the plexuses of Meissner and of Auerbach. A third type is of a partly reflex and partly sympathetic nature, and represents those reactions that are primarily reflex and yet in part under the control of the sympathetic system. A good example of such a circuit would be found in an attack of painful cramp from distention of the gut. This would constitute for the purposes of our discussion an example of a circuit intermediate between one purely vegetative (under the entire control of the sympathetic system) and an out-and-out reflex. A fourth kind is the typical reflex, termed "epicritic." Other circuits go up to the bulb and may be termed medullary circuits, and comprise those that have to do with respiration and heart-action and many of the other vital functions which are apparently controlled by the medulla. The

next variety of circuit we may term the nuclear circuit, such as those that go up into the big neuronal masses in the interior of the brain and whose activities in part at least are of the type of emotional reactions.

Lastly, the most complex type is that properly known as the cortical circuit, and this especially is accompanied by consciousness and, more important still, is under voluntary and initiative control. It is an important circumstance that each one of the circuits mentioned includes more or less of the apparatus of all of those below it. Thus you have a series ever enlarging upward. Anything that might happen in the lowest circuit would more or less affect the higher, and anything coming from the highest would have all the other circuits more or less under voluntary control, unless prejudicial to efficiency. The highest and longest and most complex circuit, the top one only, then, properly speaking is *voluntary* in nature.

These circuits of nervous influence, as various as their unique routes through the central nervous system, are not represented, of course, by separate neurons. Again, some of them are of actuating and some inhibitory nerve impulses, some produce action while others inhibit it, in some cases not only stopping the contraction of the muscles but actually and actively relaxing them. Sherrington especially reports an experiment upon the reflexes in dogs in which active relaxation of the mucles occurred. We need to know more of this! Inhibitions in the adult have long since reduced themselves largely to the reflex type. Moreover, the inhibitory impulses by their nature are negative and have been lost sight of, so that oftentimes we do not realize that they are present at all in the adult individual. For example, the very essence of the action of alcohol upon the finer cortical centers in the brain is an inhibition (depression?) and yet, as we all too well know, the moderately intoxicated person shows signs of anything rather than that of inhibition or negation. It needs emphasis here that in general the part played by inhibition in voluntary movement, as also in attention (13) is preeminent. Inhibition, however, is too little known still to allow of its discussion at this time in this complex connection. The work of Nikolaïdes and Dontas (confirmed by Wooley and Fröhlich) demonstrating actual inhibitory fibers in the muscle nerves, is a recent important step along this path.

There is a classification of the nervous circuits we have mentioned other than that of actuating and inhibitory, and it is one that is of more immediate use in the theory of

voluntary action, namely, their division into circuits on the one hand between the skeletal muscles and the cord and into those, on the other hand, between the grey cord and the grey fabric of the hemisphere above.

As to these former nervous impulses: Few facts more helpful to our knowledge of personal control have appeared in late years than that the muscles of the body, anatomically but not physiologically individual are mainly coördinated in the posterior grey horns, these being subordinated in some certain directions (equilibrium, resistance-purchase, etc.) to supervision from the cerebellum. As a corollary of this, important very to our present intent, it is clear that the separate muscles have no direct representation at all in the cerebrum proper.

The truly personal control, then, of the cross-striated musculature comes through influences of the second variety just suggested—namely, those between the spinal horns and the grey fabric of the hemispheres, cortical and nuclear. This control, moreover, is certainly "symbolic;" that is, a properly adapted single influence probably controls a whole movement, although in the spinal grey this may involve the coördination of very many muscles in a functional group. Moreover, this control as it comes into these muscle group centers of the cord, is a *resultant* of numerous complex factors which it is the business of the hemispheres to produce by the stress and the strain, by the thrust and the pull of the individual psychophysical conditions at the moment or constitutionally, or both. It is the resultant, apparently, that controls the grey cord's group action.

One of the most essential of the factors in the neurility of voluntary control we now all recognize as kinesthesia. We do not, of course, need to enlarge upon its nature here, for Goldscheider, von Frey, James, Bastian, and many others have made its organs and its preëminently important functions in the conduct of life common knowledge manifest to all, details, however, being added continually. These kinesthetic impressions or impulses come from the moving parts into the grey matter of the hemispheres. Take the elbow or the wrist joint, the fingers, or the shoulder joint, and consider all the scores of muscles, tendons, and bones involved, as well as the skin over these moving parts, and include also the sense of touch, and we can see what an enormous complex of kinesthetic sensations and impressions must crowd continually into the central nervous system from every part of the ever-moving body.

The familiar work of Mott and Sherrington on the afferent spinal roots in dogs was quite conclusive as to the status of these movement " sensations " or influences. It will be recalled that the efferent nerves in these experiments were left complete, the outgoing motor neurons, but the dogs none the less were quite incapable of making any efficient voluntary movements, properly speaking; Munk then took up this work of Mott and Sherrington and demonstrated that the dogs after a time could make voluntary movements, but that they had to learn to do so by the vicarious use of their eyes, these organs taking up symbolically the functions usually ascribed to kinesthesia. Experiments upon certain paralytics who lack the power to make a voluntary movement show this same fact of vicarious symbolism to be true. It is sufficient to say, in short, that the kinesthetic impulses from the moving parts of the body start, or at least direct and control the voluntary movements of the individual considered as mechanical events. Unconscious kinesthetic influences appear to direct the gross movements with the help of vision, while the conscious muscle-joint impressions control the fine adjustments by an inhibitory mechanism until they, too, have become subconscious by habituation. Whether we believe with Bastian or with his opponent Ferrier as to the topographical nature of the great cortex, we cannot fail to see that the circuits between the muscles and grey cord and brain and back again are at once *the framework and the substance* of the neural process in voluntary movement, the former half of the circuit in each case being kinesthesia, be the details what they may."

II. Research

The writer is enabled to add something to the physiology of kinesthesia as the product of experimental work among his students and colleagues in the Tufts College Medical and Dental Schools and in the Sargent Normal School. This research deals directly with the functions of the nerve impulses concerned in the so-called muscular sense. The investigation was made by voluntary movements; but its results are equally well applicable to other muscular coördinations. The nerve processes that determine voluntary movements have been much discussed of late by the psychologists especially and have enlightened us not a little, while the neuro-histologists and the clinicians have been clearing up their side of the neurology of voluntary movement somewhat. In a sense, the present work forges the links connecting these two chains of information.

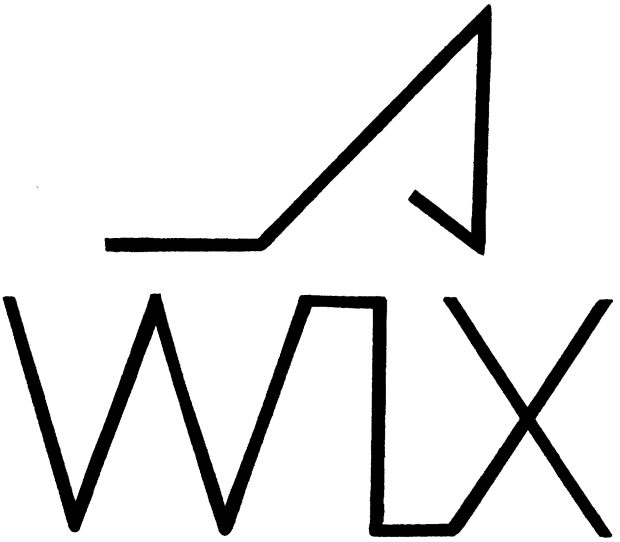
One obvious reason why progress has not been faster on the introspective side of the problem is that most of these experiments (74), *e. g.,* have studied rhythmic movements, movements made with voluntary muscles to be sure, but yet largely lacking the characters which distinguish voluntary action from that which is already more or less habitual and organized. An ideal voluntary series for such an investigation would be the movements of a novice learning to engrave without mistake a deep monogram on the side of a silver cup, or those of a youth learning to cast a small trout-fly in a steep and narrow rocky river with alders along its banks and with old beeches overhanging. Such behavior is action that is truly voluntary,—but quite as truly insusceptible of systematic scientific measurement and study. Again, we certainly can get but little information as to ordinary muscular control by the training of abandoned (75) or even degenerate muscles, such as those of the pinna. The present experiments seek to avoid both of these apparent defects by using muscles that are under excellent personal control in movements at once simple and yet, as wholes, new to the individuals making them. From such easily defined and truly voluntary movements it was hoped that useful kinesthetic information might be gleaned.

The writer has already, in several places (17, 18, 19), expressed his opinion as to the general nature of the cerebral influences determining voluntary movement (a result already reached, by the way, unbeknown to the writer, by Woodworth),—namely, in a word, that the determinant can be nothing less than the whole disposition of the brain and organism at that particular moment,—cord, sympathetic, and all. He may not, therefore, be classed with the ultra-kinesthetists who overestimate the importance of these movement-neurograms for bodily management. None the less, as everyone must admit who realizes this problem of nerve-control over thousands of otherwise unconnected muscle-units, kinesthesia must be seen to constitute the chief spinal factor of muscle-coördination, and so of voluntary control.

A. The Apparatus and the Material

This research was begun in November, 1910, and has been prosecuted at intervals since, on thirty-eight subjects, all of good intelligence but varying in age from fourteen to sixty, of both sexes, and some of them blind, the majority of them were young women between eighteen and twenty-five years old.

At first, a rather elaborate electrically recording apparatus, devised for the purpose, was employed; but this was abandoned for a method at once simpler and more efficient, and moreover closer to the actual conditions of motor training, to the knowledge of which these experiments are a contribution. The apparatus chiefly employed, then, was of the simplest,—two norms or models, shown in the figure, these being simple series of connected straight lines traced on a sheet of paper. One is a horizontal line 2 c. m. long thence 5.25 c. m. upward at 45°, then vertically downward 3 c. m., then 1 c. m. upward and backward (to the left) at an angle



of 45°. The other norm, as may be seen from the figure, is really a W, an I, and an X connected by short horizontal lines, the whole being 8 x 3 c. m. overall. In addition to these norms the apparatus comprised only a full-length lead-pencil, sheets of white paper 21.5 by 28 c. m. in size, and iron clamps to hold these sheets to the corner of a table, sometimes under a sheet of plateglass.

B. The Method of Research

The method of conducting the experiments was equally simple, as is always fitting if we are to get to the bottom of complex things. The subject, carefully blindfolded, stood before the table, was given a long pencil, and told that having

been given "a certain series of straight lines" he was to "draw it on the sheet of paper before him as accurately as he could, both in size and shape." The pencil being held with sufficient firmness in the subject's right hand, the experimenter with a hand on either end of the pencil then guided the point of the latter at a moderate speed over the norm. The subject was then asked if he could repeat this voluntary movement, if he could draw what had been given him kinesthetically. If he had a sufficiently clear idea of it, a sheet of paper was placed under the pencil-point and the first record was made. Information was then requested as to the nature of the motor idea by which he had been guided (whether visual, kinesthetic, or otherwise), and the notes were written upon the sheet. Usually more than one kinesthetic perception of the norm were necessary before a sufficiently clear notion of the series was obtained; the subjects varied very greatly in this respect. After several repetitions of the voluntary movement by the subject, he was asked about the movement-feelings in his active arm and his replies were carefully set down. He was then requested to notice them as intently as he could and to concentrate his attention upon them, and meanwhile again to draw the series of lines as before. Careful inquiry was made in every case as to the success and other conditions of this process of intensification of the resident kinesthetic sensations and the degree of success, with the other notes, recorded. After a few performances alternating between the natural method and this one with strengthened movement-sensations, the blind was removed from the eyes and the norm was visually shown to the subject (no measurements being allowed), and the blind was then replaced. Note was made as to whether the visual percept seemed surprisingly large or small or neither. The former alternation of visual and kinesthetic guidance was then continued for a few performances, real intensification of the resident sensations being assured, as before, by suggestion and unobtrusive insistence. Finally, the blind was removed, and the subject was asked to draw the norm as well as he could with his eyes open, as a final memory-standard, based on all his combined experiences of the series.

Thus we have five sets of similar voluntary movements for qualitative and, if expedient, quantitative, comparison: a set made from a motor idea kinesthetically received; another on this same basis but with intensified movement-sensations; a third, made from a motor idea both visual and kinesthetic in origin, another, on this latter basis also but with the move-

ment-sensations reinforced; lastly a set of performances made with the eyes open on the basis of the previous experiences combined. Here obviously is a wealth of material for the study of many things,—for example, the effects of intensification of the conscious phases of kinesthesia, which we use, and data for fundamental knowledge as to individual differences, which we postpone to another time.

A third but brief series of experiments was conducted on some of the subjects in the drawing, blindfolded, of 40° angles with sides about 20 c. m. long, and received (perceived) by the performer kinesthetically as in the other experiments. This work was soon abandoned for a better plan. It was, however, here brought out without chance of error that difference in direction has no primary, *natural* basis in the kinesthetic memory of visualizers, however, easy of development there. Differences in direction depend on visualization, whether it be the literal process as used by most people who see or that close imitation of it, derived probably from kinesthesia plus local signature, so conspicuous in the minds of the congenitally blind. There is assuredly some elaborate process of synthesis that is readily competent to give human beings their necessary working concept of spatiality even out of the most fragmentary experiences; that it readily arises from kinesthesia can be marvelled at by no one. The necessity for this spatiality has been discussed elsewhere, for example (37, 18, 17).

C. Notes and Results

The experiences concerned with the performances in these experiments were clear to every subject and are of such a nature as to be clearly statable by every adult of normal intelligence, for movement could not voluntarily eventuate until its conditions, in part at least, were known. The research is as much neurological as physiological and more of either than psychological, for no one can divorce in such conditions the facts of personal experience from the nerve-impulses underlying them; and herein can neurology receive more help, oftentimes, than from the histologist or ever from the clinician. The number of subjects is sufficiently large to ensure reliability; and their variety in age, sex, and race, and both blind and 'seers,' adds to this trustworthiness. The work endeavored to keep as close as possible to the ordinary conditions of average voluntary movement with the arm; the chief departure from this normality was obviously the blindfolding of the subjects, but herein lies of course the crux of the results in a study of kinesthesia. It is one of the unexplained curious facts of

psychology that in unskilled movement, vision completely drowns out the kinesthetic sensations. The lines of the norms (one simpler, the other more complex and requiring better memorizing than the other) are about of the average length of voluntary movements, being much larger than the movements of the writing class, yet greatly smaller than the free arm-actions so common in ordinary behavior. This latter consideration is one of no little importance in judging the protocols of the experiments for in a free right-arm movement such as these, made with the individual standing, the continual tendency would be to exaggerate the movement beyond its actual small extent.

Of the results of this research, perhaps the most interesting for the physiology of kinesthesia is the fact that reinforcement of the conscious movement-sensations by deliberate attention to them tends to shorten the movements and somewhat to lessen the angles between them. In other words, in visualizers, intensification of the conscious kinesthesia inhibits the related voluntary movements. Such being the case, it is difficult to avoid the conclusion that *the function of the conscious movement-sensations is the inhibition, the deliberate active restraint, of tendencies to action.* Attention to matters other than the resident kinesthesia of the active arm, as was demonstrated by trial, tends to stop the performance altogether, or to make it irregular, uncertain, and wabbly. Attention to the resident kinesthesia, on the other hand, tends simply to make the movements less, while they continue deliberately to the end without hesitation, but minimized. Considering that the movements studied are free-arm movements from the shoulder-joint, tending therefore to exaggeration far beyond their true size, this result becomes all the more striking. Almost no records, *per contra,* showed enlargement under these circumstances, also a significant fact where the voluntary conditions are so complicated and uncertain. Fifty-five per cent of the reactions showed this inhibitory effect and just about half of the subjects made reactions consistently that were of this type. May we not conclude that the more or less conscious resident kinesthesia, perhaps distinct from other kinesthetic coördinations, has special inhibitory function, as well as the passive reception of jars, vibrations, passive movements, and postures?

The experiments seem to show, moreover, that the muscles themselves are the seat of the changes that the arm undergoes when intensively attended to. The bearing of this fact upon the controversy between Reichardt (60), Pillsbury (57), etc.,

and Goldscheider (32) as to the relative status of the muscles and the joints for kinesthesia, is not easily cleared up at present. It would tend, if anything perhaps, to support the former, the muscle, side, for reinforcing the resident conscious sensations (nerve-impulses) lessens the extents rather than disturbs the shape based on the (extrinsic) motor ideas. This inhibition of a gross complex movement we must ascribe directly to the muscles, whether *guided* by the arthrodial afferent impulses or not.

The fact of the prompt and usually accurate *visualization* of the movement-series received into the person's central nervous system solely through the kinesthetic receptors of the arm, is an interesting product of this experimental work. Often the subject reported a clear visual image of the norm after receiving it (kinesthetically) only once, and often he proved its existence and its accuracy by drawing it (on the basis of a visual motor idea). The paths of these kinesthetic impulses and their production of a visual image constitute a problem of especial interest for the physiology of efficiency; and they would explain the conception of space in the blind. This process of visualizing varied much in different subjects. It was best and promptest in visualizers long trained in delicate motor adjustments. It was least conspicuous in the three subjects (two young women with normal vision and a youth congenitally blind) whom the psychologists would class as motiles (see below).

In any case, this prompt and usually involuntary, translation of a complex and purely kinesthetic impression into a visual image is sufficiently striking in itself, however familiar a process, and leads inevitably to a query, as yet unanswered, —why? Why cannot and does not the man of average motor skill use his conscious kinesthetic impulses in the guidance of a movement, especially a movement about which he knows nothing else? Perhaps one reason for his failure to do this lies in the inherent inhibitory action of the conscious kinesthesia—and the other phase of kinesthesia his imagination knows nothing of. But aside from this in part, the *opposition* between the resident sensations of movement (inhibitory and more or less conscious) and the 'visual' and other actuating influences, is marked; and the fact may prove suggestive. Even when reinforced by conscious effort, the resident kinesthesia and its centers (in the great cortex?) had usually no conscious memory of the norm as a whole, had nothing, in fact, usable as a motor idea; and the subject (unless a motile) thought himself wholly dependent for an efficient performance

on a second-hand, mediate, visual image, product of the immediate impressions none the less which he supposed himself unable to follow as a guide. The apotheosis of 'the queenly sense of vision' is close at hand, and that notwithstanding only a few to-day suppose the eyes have more to do with a bodily movement than the placing of its termini (*a quo* and *ad quem*),the location, in short, of the ends of the action in the essential space. (Besides this, in cases of paralyses, etc., vision serves vicariously for kinesthesia in many ways; but we deal now only with normal conditions.) The conclusion is inevitable from these circumstances that there must be kinesthetic nerve-impressions in closest relation with the visual neurograms proper, yet obviously unconscious, that do furnish the data necessary for a voluntary movement, and that actually do coördinate the muscles which are active in an action. This phase of kinesthesia, actuating, determinant of the force and speed of a movement perhaps, but subconscious or even unconscious, represents, it seems, the innate impulse to activity, the instincts, the emotional syndromes, the reflexes, the correlation of all the forces behind a voluntary arction. This phase of the movement-'sensations,' however, do not represent the individual personality of a human being until complemented, held in leash and inhibited, by the conscious resident sensations. We cannot escape terming these actuations, coördinated perhaps in the posterior grey cord, kinesthetic, for their nature and use are inconceivable apart from the joints, muscles, tendons, bones, and skin,—the chief locations of the kinesthetic receptors. The opposition between these two phases of motor control, actuating and inhibitory (the former including vision and audition), is eminently natural for most people, then; but it is an opposition that is in reality an alliance and capable always (skill) of fusion for efficiency.

The various types of method by which people attend voluntarily to these two things at once in the control of an action is well brought out in the subjective reports if not from the records made by the subjects' arms, which question remains for future measurements perhaps to determine. Most often there was a conspicuous alternation between the visual image and the inhibitory kinesthetic experiences, the visually imagined guide being brought to mind just often enough to furnish current control of the movement's extent and the direction of its component parts. The accuracy of these performers was sufficiently good for ordinary behavior. People of this class constitute the great mass of men and women;

they use their eyes, sometimes, to start a voluntary movement and to stop it mostly, and they use their spinal, unconscious kinesthesia to furnish it force, speed, etc.; but they never become generally conscious of their resident kinesthesia, properly speaking, never acquire the personal valuation proper to new and free, because personally inhibited, deliberate actions, except perhaps in certain sets of movements.

The other type, as indicated by some of the reports of the subjects, all of whom were naïve, are able to *fuse* the visually imagined (but in reality mostly kinesthetic) norm with the conscious resident kinesthesia, using them together for the guidance of a new voluntary movement. The records thus made are more accurate than the others differently controlled. Moreover, the performances of these 'fusers' have an important relative stability, a constancy of form and size, and an independence of agencies which, in others, less endowed with conscious movement-sense, disturb the accuracy of the action. The numerous records show this conclusively, and this indicates much.

The people whom the psychologists class as 'motiles,' then, appear from this research to be those who, for some reason, have their conscious resident kinesthesia hypertrophied, so to say, and apparently at the expense ordinarily of the unconscious movement-neurograms and of the visual control. The subjects who were of this type made poor drawings in these experiments. Their records were distinctly less accurate than those of the 'visualizers' in both extents and regularity, with a tendency to rounded angles and curving lines. In motiles, then, the motor idea tends to adequate presentation in terms of the local conscious kinesthesia; but unless this resident plan of the movement be much more than ordinarily comprehensive, it fails in its supposed adequacy as a motor idea.

My experiments and conversations with many of the most intelligent blind people, young and old, connected with the Perkins Institution (far-famed by its miracles with Laura Bridgman and Helen Kellar) lead me to a complete corroboration of Treves' ideas (69) as somewhat opposed to those of Haller (35) on the elaboration of kinesthetic impressions into the conception of space. We can, however, go two steps further perhaps at present, and point out how similar is this blindman's space to that of seeing persons, and how organic and indispensable it is in both in the evolution, the origination, and the adult practice of voluntary movement. Our records as well as our notes show that the seeing motile is practically in the condition of the congenitally blind, but, of course, far

more accurate in his action and with much greater potentiality of efficiency.

Between these partially opposed types of motor consciousness are many indefinite degrees, apparently, according as a given limb is more or less skilful in a given group of movements, in number of course uncountable. It is, then, one of the inductions of this experimental work that the motor skill of a person in general, and also in particular actions, is more or less proportional to his habit and capability of using the conscious kinesthesia for the current inhibition of actions elsewhere coördinated and actuated. As has been shown already, this actuation comes from (spinal?) kinesthesia in combination with external control, usually either visual or auditory. We physiologists are rapidly learning that all bodily processes and conditions are the algebraic resultants of balanced tendencies, whether nervous, chemical, or mechanical. The neuro-physiology of skill as in part determined by the afferent neurograms of movement, certainly is no exception to this rule. The unconscious and the conscious, the actuating and the inhibitory kinesthesia, surely share and complement each other in motor control. A person's skill, therefore, appears to be a 'function' of his habit of usefully *fusing together* his motor ideas proper and the resident movement-sensations which in him are adequately conscious. Compare Slinger and Horsley's conclusion (68) that "the muscular sense under necessity can, by education, be brought to a point at least one-fourth better than that learnt by a normal seeing individual."

But, again, compare the practically unanimous opinion and practice of instructors in all kinds of motor efficiency (music, instrumental and vocal, manual training, physical education, legerdemain, etc.) that attention to the sensations of movement disturbs the performance and is therefore to be avoided. At least one successful instructor in voice, of my acquaintance (Mr. Willard, late of Harvard University and now of the Sargent Normal School), makes this avoidance of local consciousness the very key-note of his method, substituting therefor an intensified general consciousness of effort.

Reconciliation of these two attitudes, one academically scientific and the other purely empirical, but both obviously true, would seem to lie in what has been learned in these experiments, if indeed skill does consist *in a trained fusion of the extrinsic motor ideas and the intrinsic inhibitory conscious control.*

The experiments furnish a certain limited amount of evi-

dence that the resident kinesthetic impressions, of the right arm at least, are relatively inconspicuous in the naïve child, and become more and more manifest with the evolution of motor consciousness and skill, both in general and in particular.

This fact may have important potentialities for future research in the direction of hastening motor efficiency in a properly physiological way. Experiments in this direction are under way, but are beyond our present range.

In our present unfortunate lack of definite knowledge of the special functions of the various kinesthetic end-organs described by Golgi, Pacini, Vater, Kühne, Von Frey, Kölliker, Ruffini, Bonnet, and others, it would be almost rashness to suggest the most likely use of each. The muscle-spindles have often been termed the probable receptors of active innervation; possibly thereafter act in series the Golgi-Manzoni corpuscles at the junctions of the tendons and the muscles, then the Pacinian corpuscles in the synovia, etc., and finally, when the movement is considerable, the receptors in the skin and subcutaneous tissues. Which of these, or whether all, act both for the inhibitory function and for the actuating process that we have called, for lack of better term, the spinal kinesthesia, remains to be worked out. One might expect the arthrodial nervous impulses (32) to be concerned in the actuating processes, as guide-determinants of the initial direction.

The physiology of the reinforcement of the resident movement-impulses by attention to the arm in action is not a difficult matter nor a complex one. As in all other cases, this process leads to a hypertonia of the muscles and this in turn to an increase in the afferent impulses sent inward by the kinesthetic receptors. This increases greatly the delicacy of the (inhibitory) control, the muscles having far more tone and vigor; and defines the sensations better, making them more conscious, thus it may be allowing them to fuse with the extrinsic motor idea (visual and spinal) and meanwhile to dominate the actual movement as representative of the truly personal (cortical) will.

III. Confirmatory Evidence

Corroboration a-plenty of the results of the present research seems to be at hand from several different and wholly independent directions, especially in regard to the proposition which we have induced from the records, that kinesthesia is two-phased, one phase unconscious and actuating and the other conscious and inhibitory.

In the well-known research of Mott and Sherrington (53),

the cutting of the afferent roots of one side in the ape from the fourth cervical to the fifth thoracic, led them at first to conclude that the 'will' was abolished so far as the arms were concerned by thus withdrawing the peripheral kinesthesia from the central nervous system. Munk's prompt repetition (54) of these experiments, while showing also how vicarious and withal how widespread voluntary control may be, demonstrated that when recovery of function had taken place, the movements were invariably *inexact* and *more extensive* than under normal conditions. *Per contra, sed idem sonans,* our experiments have shown that when the conscious movement-influences are exaggerated instead of abolished, the movements tend to be true to the extrinsic motor ideas but less extensive than normally. In other words, again, the resident kinesthesia is inhibitory. Other evidence for this is often at hand in ataxias, functional or organic, when of peripheral origin, the movements then showing clearly a lack of normal restraint. Moreover, it is not improper to suggest the possibility that the reason that all short movements tend to be made too large lies in the insufficient innervation 'reflexly,' so to say, of these inhibitory influences.

The neurotopographers have already found evidence for two separate kinesthetic pathways in the brain if not in the cord. v. Bechterew (5) without dissent says, "Nach seiner (Lewandowsky's) Auffassung setzt sich jede Bewegung aus zwei Komponenten zusammen, aus einem bewussten und unterbewussten Element." Bastian, too, appears to agree with this, from data purely neurological. Again, Russell and Horsley (61) express one of the results of their work on spatial orientation in this manner: "It is therefore, we submit, perfectly clear that what may properly be termed the mid-axial line and region of the hand and forearm, is as definitely represented in the cerebral pallium as it distinctly is in the spinal cord." "The spinal representation of tactility [a variety of kinesthesia] finds an echo in the arrangement of that function in the sensory cerebral centres." It is not obvious why there should be this double representation unless these two sets of kinesthetic centers have in some way different functions. Those familiar with the recent brief but important symposium (6) on muscular representation in the grey cord and in the great cortex, would perhaps be inclined to believe that the 'individual' skeletal muscles are mapped out in the pallium only for some very special purpose, not discoverable by electric stimulation. That purpose now seems to be inhibition (through the resident kinesthesia).

In a closely allied realm of neurology, facts have already combined to form an essential connecting link in support of the main result of our research that the conscious kinesthesia (and by consequence, voluntary movement) are inherently inhibitory processes, just as all other kinesthesia is actuating in action. Perusal of the consensi of competent opinions published in the splendid volumes of Lewandowsky, v. Bechterew, Cajal, and others, makes it extremely probable that there are two main courses for the carrying of kinesthetic influences into the gery regions of the brain. Grant Van Biervliet's finished work (70) already referred to, and there is no longer need of seeking separate pathways or centers for tactile and movement sensations; and on this basis several discrepancies in neurotopography disappear. Touch is impossible without muscular movement; and the sensation of movement in some of its phases is but an inner touch,—indeed the blind know it by no other name. For example, the path ascribed by Cajal to tactile impressions corresponds as well to the ' somaesthetic ' tract of Barker and to the kinesthetic tract of Starr as one need expect in the present relative indefiniteness of these complex matters in neurology. There is sufficient agreement already that an important avenue of ascending nerve influences extends from the kinesthetic receptors through the latero-posterior cord, the lemniscus, etc., with relative directness to the cortex of the great hemispheres. Many circumstances suggest that this route, relatively simple and direct, conveys the conscious inhibitory impulses that we have termed the resident kinesthesia, characteristically voluntary or personal.

There is, however more general agreement as to the topography of the indirect ascending pathway between the afferent grey cord and the cerebral cortex; this passes through Clarke's column, (the cerebellar bundle of Flechsig), the vermis superior, the mysterious Purkinje cells, and the thalmic ganglia (van Gehuchten). Barker suggests that ten or more neurones may be ordinated in this passage! This many-swirled flood of neural currents passing to the cerebrum represents, of course, the hereditary spatial moto-sensory outfit of the individual. For our purpose here and now it stands for that complicated actuating innervation of the voluntary musculature under the control of vision, audition, etc., in combination with the positive, impelling, impulsive kinesthesia centered in the spinal grey. It surely is intimately connected with the whole sympathetic disposition of the personality, with his feelings and emotions, with his whole intellectual memory and experience, and its intimate relationships involve the whole brain and much if not all of the whole nervous system besides. On the

other hand, we have to suppose the more direct, conscious, and inhibitory, tract to convey the occasional, difficult, or wholly new personal *effort* of the individual as a personal will, related with especial closeness to the cortex of the hemispheres. Our every-day, ordinary behavior uses this tract extensively; but skill and novelty employ it intensively as the road to even greater efficiency.

Hollingworth's recent work (41) in the Psychological Laboratory of Columbia University correlates its results so far as kinesthetic matters are concerned with the opinions of Sherrington, Titchener, Angell, Woodworth, etc., but makes the ideas more explicit: "Attempts to find a single anatomical or topographical source for the sensation which serves as a criterion of extent of movement are contradictory and futile. * * * * A movement comes to be recognised as larger than others, not because it produces a more intense sensation, nor because of any geometrical correspondence of internal and external points, but because it has been *learned to be a larger movement,* one that will effect a greater change in an object with which we are dealing." Without reference to the fallacy here similar somewhat to the ancient one asking why we see objects erect when the retinal image is inverted, it is obvious that herein is a definite opinion (derived from long experimental work made in the laboratory of men as cautious as Cattell and Woodworth) which confirms our own experimental result that extent of movement is an unconscious function of the spinal grey in closest association always with brain and cord and especially with the cerebellum. A larger movement has been "learned to be a larger movement" by various experience indeed and the judgment gets no help at all from the conscious kinesthesia in this respect. Sometimes the information comes only with difficulty. Over and over in our experiments, records not a half or a third as large as the norm, whether kinesthetically or visually perceived, were reported by the agent as large enough or even too large. In other words, the local attention-strain of true voluntary movement is not translatable into size or extent. The unconscious actuating aspect of kinesthesia takes care of extent, probably, and in terms made up of energy, speed, habit, momentum, gravitation, and other things far too complex to be described at present. The activity of the conscious phase of kinesthesia exerts an entirely different kind of control over action, a control that is truly voluntary.

Further evidence, more or less direct, of the validity of this point of view may be had from the observation of the development of voluntary control during the first year of life. One

fact which has regularly been overlooked in genetic physiology and psychology is the completeness of the inhibitory apparatus and activities at birth. See for example the writer's observations (14) on the little girl 'L.,' made in 1899. A few months later in the ontogenetic evolution, when deliberate control begins to be obvious, inhibition seems to develop or at least to be apparent somewhat before voluntary actuation (14, p. 195). Guyau recognizes the fundamental duality of the will-apparatus, as the following quotation attests: "La pleine volonté, c'est-à-dire le deploiement total des énergies intérieures, suppose qu' à la représentation de l'acte même qu' on va accomplir s'associe la representation affaiblie de l'acte contraire. Et ainsi, nous arrivons à cette conclusion: Il n' y a pas d'acte pleinement volontaire ou, ce que revient au même, pleinement conscient, qui ne soit accompagné du sentiment de la victoire de certaines tendances intérieures sur d'autres, conséquemment d'une lutte possible *entre* ces tendances, conséquemment enfin d'une lutte possible *contre* ces tendances." Ribot's whole psycho-physiology is permeated with this functional duality in action, as all the world knows. The evidence, experimentally produced, that this two-phasedness of the will extends throughout the action-system in a literal way and even to the kinesthesia motivating or actuating and controlling muscular coördination, adds only another factor to our knowledge of how we act.

Weir Mitchell, forty years ago, published (51) material (derived in part from the soldiers of the great War) which throws some light on the neurology of kinesthesia, especially in its relation to actual consciousness. From this, one of the most extensive investigations of the sensations of lost limbs ever made, he produces many most interesting inductions. These statements following directly bear more or less on our research-results, and, in a way, complete them. "Involuntary movements of the absent toes or fingers are frequent and in very many persons are unfailing precursors of an east wind. [*Cf.* with an inflamed joint's ability to foretell the approach of a storm.] Sometimes only one finger is thus active, or the digits flex one after another, and then slowly extend, whilst wrist movements are exceptionally rare, and the elbow and knee are never felt to change place at all.[2]

[2] It certainly is suggestive that the fingers, the most conscious and best controlled parts of the body (save the eyes and tongue) should be those most persistently and most frequently felt under these conditions. The fact suggests more of conscious inhibition in them than elsewhere in the body.

"Leaving out of the question cases which have no sense of the presence of a lost limb, we find that in a very small number there is no consciousness of power to stir any part of the absent members by force of will. All others are able to will a movement and apparently to themselves to execute it more or less effectively, although in most of the amputated such phantom motions are confined to the fingers or toes, which rarely seem to possess the normal range either of flexion or extension. Yet the certainty with which these patients describe the limitations of motions, and their confidence as to the place assumed by the parts moved, are truly remarkable; while these restricted movements are pretty surely painful, and the effort is apt to excite twitching in the stump. A small number have entire and painless freedom of motion as regards all parts of the hand. 'My hand is now open, or it is shut,' they say. 'I touch the thumb with the little finger.' 'The hand is now in the writing position,' etc. Between these cases and such as are conscious of an immobile member, every grade of difference as to motion is to be found, with equally wide varieties as to the associated pain which perhaps is most acute in such as will with vigor a motion that they seem to fail of executing.[3]

"The volition to move certain parts, continues Weir Mitchell, is accompanied by a mental condition which represents to the consciousness the amount of motion, its force and ideas of the change of place in the parts so willed to move. The physiology of the day accepts the belief that all of our accurate notions as to the amount of power put forth and as to the parts thus stirred reach the sensorium from the muscles acted on and the parts moved. It would appear, however, from the statements here made as if coevally with

[3] Here we see restrictive kinesthesia, by reason of some unknown abnormality in the spinal or other centers, so intense as to be painful—just as all sensations can pass over into some experience at least very unpleasant. If we compare the pain here produced with that made in a real anchylosed joint by a strong attempt to move it, we shall find great similarity. In the latter case the pain is obviously due to the overstimulation of the arthrodial receptors, and we may not improperly suppose that the former is due to some sort of an overaction (exerted from the 'reservoir' above?) upon the actuation-centers of the brain-stem, compelling a painful overstimulation of the inhibitory mechanism, but central rather than peripheral in origin in the real joint. In such places and cases as this it is easy to satisfy the craving of those who deny absolutely all that they personally happen not to believe, by over-hypothesizing but let us refrain; the very complexity of the conditions referred to serves as a sort of argument for our present contention of a kinesthetic duality.

the willing of a motion there came to the consciousness, perhaps from the spinal ganglia acted upon, some information as to these points. If, in reply to this, I be told that the constancy of long habit may have associated memorially with certain ganglionic activities the ideas of local movements, I should hardly feel that this was an answer, because in some of my cases the amputations took place so early in life that there was no remembrance of the lost limb, and yet twenty years after, a volition directed to the hand seemed to cause movement which appeared to be as capable of definite regulation, and was as plainly felt to occur as if it had been the other arm which was moved. Probably, then, a part of those ideas which we are presumed to obtain through the muscular sense are really coincident with, and necessitated by, the originative act of will or else are messages sent to the sensorium from the spinal ganglia which every act of motor volition excites."

As a monistic interactionist, so to say, the writer is willing to accept either of the alternatives suggested at the end of the above quotation; but to him as an out-and-out physiologist (as ignorant as a biologist of anything like metaphysics), the latter of the two seems the better. Especially does it seem the better because it undoubtedly adds an important item to the neurology of kinesthesia: namely, the needlessness of supposing that literally all kinesthetic impressions come directly and separately from the joints, muscles, tendons, bones, viscera, and skin of the moving parts. We may properly suppose, on this timely cue, that *the spinal grey is so intimately aware of all that goes on in the action-systems* (through tides of intelligence unifying all parts of the circuit) *that not only actuation but (inhibitory, conscious) control can arise and be exerted there from further up, from the great cortex.* In other words, here is direct evidence, hard to refute, that the cortical grey acts by and on *movement-complexes* represented not only in the cortex but in the grey matter of the afferent cord, the musculo-(et al.)spinal circuit being an unity in the most literal and absolute sense. This is precisely in line with the tendency in interpretations of the action of the nervous system—indefinite conscious and subconscious grouping and subordination and "symbodism" beyond present detailing (see below).

Finally, for the present discussion, Sherrington's classic work (64), especially that part of it relating to the reciprocal innervation of muscles that are functional antagonists, doubtless has direct bearing on this corresponding division of the afferent movement-information into inhibitory and actuating. Nikolaïdes and Dontas's demonstration (55) of inhibitory

neurites in the frog's motor nerves (confirmed by Wooley and Fröhlich) is also suggestive of further knowledge to come. In general, however, the inhibition of a voluntary movement in current control through its conscious resident kinesthesia relates more to molar inhibition by groups of antagonistic muscles than to inhibition within the influence of a single neurone. One group of muscle-units actuates a certain movement and the movement is usually useful to the agent only when balanced and restrained by another group under conscious kinesthetic control.

Aside from the fundamental discoveries by Sherrington (64) already referred to, Lee and Everinham (48), Camis (10), and Forbes (29) have recently shown that in some mode or other separate kinesthetic paths or "nerves" control separate groups of effector neurones which in turn supply respective muscle-groups, so that we know now that there is far more division of labor among at least the afferent neurones than was suspected formerly, so far as their control of muscle is concerned in particular. Our research seems to go one step still further in this differentiation, suggesting, as it does, additional subdivision of the receptor pathways into actuator and inhibitor as already set forth. This seems to complete the logical requirements of mechanism for the understanding of the actual behavior, complex far beyond actual description at the present time.

IV. The Impulse to Activity

Just as the essence of life considered for the purpose as a 'material' process is movement, movement universal in time, in place, and in meaning, so truly is the essence of the function of the nervous system to coördinate these movements, whether molar or molecular, whether wholly within the body or the body as a whole with its particular environment. The very meaning of protoplasm physically speaking, is motion. This universal inherent necessity of movement in organism is known in psychology and in educational theory as the impulse to activity (and all too late has its universal necessity been recognised!). Sometimes a fully conscious thrust, sometimes pushing quite as hard but all unconsciously, this all-pervading vital impulse is the motive power of all achievement. It represents *actuation* of both the vegetative and the personal in human efficiency, just as the conscious personal will stands for restraint. The greatness of its importance in education and in explanatory psychology we need not pause to more than mention.

Through many thousands of varied receptors the ever-active

tissues start and send a flood of impulses inward to the central nervous system, (the sympathetic partaking in this primal function); and this flood stops only with the abolition of protoplasmic, especially muscular, tonus, at death. This obviously is the 'spinal' kinesthesia described to some extent above, fused intimately so far as service goes with the visual, auditory, and other receptor impressions, especially the first. This flow from numberless motile springs keeps full the reservoir of kinetic or potential energy on which the whole effector side of the organism's activity continually draws for its life so far as coördination and guidance are concerned. These obviously underlie and determine the entire motivity, both vegetative and personal, of man.

Complex beyond conception is this basal kinetic impulse, psychologically as well as neurally; and we shall not, nor need we, make any attempt to describe either its phenomena, or its mechanism in anatomical terms. It stands for the motivation of behavior and its apparatus therefore must include every active factor of the psychophysical organism that makes for mere activity, for unguided, unvoluntary movement. Conspicuous in this ultimate or nearly ultimate integration is, of course, the whole conscious and subconscious process of emotion, and the two basally opposed feeling-tones of euphoria and dysphoria so essential in efficiency as well as in human happiness. In closest relationship, too, with this, the vegetative back-bone, so to call it, of the organism, are all the sensation-'centers' (spinal possibly and surely thalmic) and all the psychomotor 'centers' concerned in the motor adaptations of each of them. In short, the whole nervous system more or less is at once affected by and affects the bodily mechanism of the impulse to activity, behavior's motivation-tracts.

Behavior, indeed, physiologically viewed, is controlled motivity and the control is the circuitous guidance of the reflex and voluntary kinesthesia. Thirty-five years ago (a long time in the history of the feelings of movement), Stanley Hall, in a neglected article in *Mind* (34), expressed the basility of its nature thus: "The feeling of motion we have shown is the simplest, earliest, most universal, known, psychic rudiment of animal life. It is distinguished from every other sensation in being identical with its objective cause or aspect which is also motion." This uniqueness of kinesthesia has been too little appreciated in psycho-physiology, and its significance hardly understood in its metaphysical relationships as well as in its physiological bearings. The impulsive phases of the motion we should now think of as subconscious, the sensation

as conscious, representing intensive control, coming rather from the voluntary personal inhibitory guidance, as already set forth.

Let us now look for a little at a rare condition known in its typical form to nerve-specialists as *abulia,* for by so doing we shall accomplish two things at once, more or less completely: we shall illustrate the absence or negation of the else universal impulse to activity, and perhaps help to explain this interesting condition.

The term abulia is Greek for will-lessness, absence of volition proper; the research and literature of the subject is mostly French. Rare or perhaps unknown in childhood (in itself an interesting theoretic circumstance), abulia is found oftener in women than in men, and consists simply (so far as external phenomena are concerned, it is simple enough) in a functional inactivity, a will-lessness carried to any extent, it thus being sometimes a matter of life and death. There is no loss of muscular power and no disturbance either of the sympathetic vegetative musculature or of the reflex habitual behavior, the abulia relating solely to the deliberate motivity. Understanding in simple abulia is unimpaired, so that the patient may have the most vivid concepts of the necessity of action. Actual cases are often complicated, of course, with many phases of hysteric, neurasthenic, " psychasthenic," and psychiatrical conditions, but pure abulia is inherently a lack of deliberate conation.

One of the natural results of the obvious exhausting ' overworking ' of the Rolandic area as the recondite ' center of voluntary movement,' is an awakening of interest in this condition. Logically speaking, it is the only known defect in voluntary action proper, for it apparently is due neither to a true paralysis of nerve-knots nor to disturbance in muscles or their nerves. Abulia is of especial interest on this account.

The abulic's ideas that she should or must act are unexcelled examples of mere ideas, associative products that are of service to no one and to no thing—the grist of intellectual mill-wheels that can only be thrown away when it is ground. The very notion of ideas unexpressed in any way, unmixed with feeling-tone, unmaterialized by will, has in it something ironical, something artificial and unreal as if the by-products of the language-processes characteristically human to be sure, but none the less with inherent liability to useless action—like some neglected grist-mill by the brookside whose stopping-mechanism has been deranged, and which, until worn out, makes noise and dust and jolt and jar beyond all reason. In

some such mode appear to the writer to be any association of ideas never used because never materialized in real bodily action and thus related to the rest of Nature. Such, in a sense, are the psychologically interesting ideas of the abulic that she should act, must act,—and yet does not. Mourre, for example, considers abulia to be inherently the inability to transform an idea into its act as the product or consequence of victory among antagonistic ideas. The abulic, he says, knows that she wishes to do a thing and at the same time knows that she does not do it, because the inhibitory association of ideas prevents. In true abulia, he thinks, the patient deems her will free; but she fails to act because she chooses not to do so, fearing she might fail. There may be also, he supposes, a diminution of the vital sensations and desires, making the motogenic balance of pleasantness unusually small. The physiology of abulia, Mourre concludes, is some organic neural disturbance, while the psychology is the difficulty of voluntary effort.

Sometimes abulia follows an asthenic infectious disease, *e. g.,* typhoid, as in a case described (59) by Raymond and Janet.

There is no other condition quite like abulia. Melancholia, katatonia, certain phases of paranoia, and even some cases of dementia and of amentia, exhibit somewhat similar external bodily conditions (that is of deliberate inaction), but in all of these the conscious motivity is wholly different in ways both too familiar and too complex to allow of present rehearsal. Here in abulia alone have we a defect in the very physiological *motives* of the personal activity.

One is reminded inevitably of the numerous persons who, it is customary to say more or less sarcastically, were 'born tired,' who are in short, to the uninformed lay-mind, lazy. The world still has in mind the dire hook-worm's timely vindication of his thousands of victims in the South, and now perhaps it is another (but relatively small?) group of inactives and inefficients, the mild abulics, to whom we owe the courtesy of excuse. The king of optimists himself would not wish to deny that there are plenty of individuals of many sorts whom habit and inclination have made truly lazy; but certainly there are many others whose tendency to inaction must be classed as a mild degree of abulia, those especially with a psychasthenic *Belastung* whether constitutional or acute. In thinking over the persons of this type in one's acquaintance, one finds, in surprisingly large per cent, evidence of deranged metabolism of the depressive trend, a low metabolic plane of

efficiency with the balance leaning toward mal-nutrition. Physiologically these individuals oftentimes are cases of functional abulia of a mild type, but more complex and so harder to unravel than even the well-pronounced cases with the voluntary mechanism obviously deranged.

The one indisputable argument for defense in these conditions bases itself in the fact that to a thoroughly normal person, activity is pleasant. To the sound mind in a truly sound body a normal amount of suitable work is a delight the most reliable if not the most intense, of all human delights, whether it come from the deep action of the diaphragm or from the normal routine of the day's vocation, whether 'sport' or 'work.' Three conditions may be noted in passing, related to this matter that are among the hardest of the great world's cruel facts and which have gone far to prejudice mankind against the idea of work: *1.* multitudes are engaged in ill-adapted and hence uncongenial work; *2.* multitudes, including these former more or less, are working longer if not harder every day than a later age of economics will allow; *3.* multitudes, more even than the others, are not in that normal neuro-musculo-visceral vigor to which even proper work is a gratification. Had the world as yet ameliorated out of these harsh primeval conditions of a livelihood, one of the well-based prejudices of our race, that work is hateful and to be avoided, would already be of only historic anthropologic interest like the preglacial distribution of the hairy Ainu. All this to introduce the negative premise that psychomotor activity under perfectly normal conditions of mutual adaptation between the individual and his work renders a distinct balance of pleasure to the maker—yet work, unlike virtue (Twain), is not its only reward. Perhaps it is unnecessary to point out that exertion renders its inherent recompense largely through the exercise of the sense of kinesthesia—the music of the feelings of movement, tribute of the rhythm of katabolic expending, the great joy of motion, index of our life.

We may properly go a step farther without fear of serious contradiction, and say that when this euphoric balance is lacking, bodily activity in general tends to be reduced to a minimum; on the other hand, when the truly metabolic bodily activity is lacking (tonus being the true index of this activity) the euphoric balance is zero or actually dysphoric. Those of my readers who have suffered, for example, from a long exhausting illness will readily appreciate at first hand this state of atony in soul and body—a will-less condition of carelessness, passivity, a *laissez faire,* not of necessity, perhaps

seldom, painful, but wholly negative so far as deliberate action is concerned, and often so to a very surprising extent. Matters which a few days or weeks before seemed of the utmost personal and family importance are now, in this functional abulia (so to call it) completely indifferent, whether they be done or not—the fortunate condition which very frequently indeed, normally in the aged, deprives death from disease of all unpleasantness to the chief actor in the common tragedy. The main factor in physiology of this condition of illness is certainly an akinesthesia arising in the decadent atony of the body and soul. When one's foot "goes to sleep" from pressure on the nerve there is a condition oftentimes almost purely akinesthetic and one interesting for the ready observation of voluntary movement lacking in the local or resident kinesthetic influences. Compare it with the exalted consciousness (agony) of the opposite state as exemplified in hydrophobia and in strychnine poisoning and its tenor is still more clear. In nightmares, too, sometimes there seems to be a more or less general tonic spasm of the muscles so that the sufferer is unable to move against the opposing terror, to jump out of the way, to cry out, or what not. Perhaps in these cases the painfulness of the experience is due to over-stimulation of the conscious inhibitory kinesthesia, for some reason for the moment not under voluntary control. By force of will made up in the waking state and impressed on the subconscious, this cramp in the nightmare may readily come under habitual voluntary control and its pain thus be avoided. (Personal communication from John Frederique Herbin.)

The writer has already in various places (especially 15) set forth, in a manner more or less orderly, his particular ideas as to the neuro-metabolic basis of the fundamental emotional tone of euphoria or of malaise. The primal sympathetic centers are concerned and without much present doubt (38) the optic thalmus, both being, of course, always in the closest possible and most intimate relation with the remainder of the cerebral and spinal grey. All these grey nuclei of the vegetative life (representing as coördinators or adjustors the moods temperament, dispositions, organic habits of every phase, degree, and permanency) are probably under the unceasing influence of those afferent neural influences which we have called the actuating kinesthesia. The reservoir of nerve-center energy, thus largely supplied with tone and information, furnishes at once the nervous motivity and the conscious incentive, which, because at least mildly pleasant, normally urges to activity. When lacking this pleasant tone or in such a condition possibly

of 'block' that knowledge of this pleasantness cannot come into the brain (save *e. g.,* by way of suggestion or hypnosis?), there is the functional condition of abulia, or so it seems likely.

To our present understanding, then, the abulic state, whether thus 'functional' or organic, whether primary or secondary, is a defect or a default in the impulse to activity. It is represented inherently, we may neurologically conjecture, by some disturbance in the actuation of the voluntary muscles probably as much central as peripheral. In abulia, obviously, the muscular tonus is much lowered and this greatly lessens the kinesthetic influences. On the other hand, the spinal afferent grey also has lost much of its tone, partly because of local mal-nutrition perhaps (a decrease of the chromatin?) (25), but partly too probably because its normal stimuli or supplies of exciting energy from the muscles are partly cut off in part too doubtless by some unknown derangement of the central adjustor-mechanism. This intimate inter-dependence of the musculatures, especially the voluntary, and the will need not be detailed here. The kind and degree of will that would be possessed by one 'completely' paralyzed is too esoteric for scientific discussion; meanwhile no case of truly complete paralysis (that is, an instance in which the central innervations, afferent and efferent, of the muscles, the essential thing, are abolished) has been described, for a person in this condition would be practically dead.

Another condition involving deficiency in the common impulse to activity and probably in the general kinesthesia fundamentally, is *feeblemindedness,* now so prominently before the educational and economic world. I am not familiar with any definite information or even suggestions as to the etiology of this important condition, the ordinary theory being simply that it is related to some arrest or mal-development of the cerebral neurones. Granting that this is likely, it is interesting to look further at the implications of this defect.

We have already sufficiently pointed out the flood of nervous influences that is continually pouring into the nerve-axis, chiefly from the action-system, the skin and the viscera; and we have indicated that these influences become integrated, in the higher levels of the cerebral grey, into conscious (largely inhibitory) motor ideas or into emotions or emotional tones which act as resonators and so produce the effect, the '*animus,*' behind and beneath all voluntary behavior. Only a brief consideration is needed to convince one how important these streams of kinesthetic and coenesthetic impulses must be in the mental and bodily deficiencies of feeblemindedness.

Whether central or peripheral (more likely it is both), the afferent feeders of the psycho-motor reservoir are probably determining factors in this condition.

It has scarcely been sufficiently emphasized as yet by competent writers on feeblemindedness how frankly motor is the basis of this defect, phylogenically or ontogenically,—the latter, the personal, factor playing perhaps the leading rôle. This factor is getting more and more of its due importance. For example, in the very latest discussion of the brain of a very young human foetus, the authors (7) say: "There is very definite evidence that, in the complex of phylogenetic and ontogenetic factors which subserve the process of evolution, the latter from a very early period play a predominant part."

Norsworthy (56) finds no difference in kind between the feeble-minded and the normal and concludes that "in general, at least so far as intelligence is concerned, idiots do not form a separate species, but simply occupy a position at the extreme of some large distribution, probably approximately that expressed by the normal probability curve." But, of course, idiots are not especially efficient members of society, and an underlying defect very general in nature must be sought in some phase of the moto-sensory organism. Shuttleworth and Potts (67) certainly suggest a forward step in their remarks on the sense of 'touch' (kinesthesia) in the feeble-in-mind: "The tactile function is not only the most general, but in some respects the most important of our senses, and in the normal baby its evolution takes precedence of the rest. Impressions through the eye and ear are criticized through the sense of touch, and this natural development, so serviceable in the spontaneous education of all healthy young animals, [cherche le chaton!] must be imitated in our endeavours to bring up towards the normal standard the sensorial training of imperfect children. In some cases we shall find coarse, insensitive hands which must be drilled into sensibility by grasping hard and soft objects and discriminating the resistance of and the surface impressions of such varying substances as polished marble, sandpaper, velvet, silk, etc. * * * * Such lessons will, of course, form incidents of the object-lessons which play so important a part in early education."

Unless the present writer is misjudging, there is here suggested the defect which above all others is fundamental in the etiology of feeblemindedness. The statistics recently published by Goddard of the Vineland Training School (31), from measurements made in nineteen institutions by as many observers, will be of great importance in the general theory of

the relations of body and mind. These show a correlation between birth-weight and feeblemindedness (the feeble-in-mind being heavier), and between growth and feeblemindedness, the growth of the defectives being much more erratic, earlier to stop, and less in the total than is the case with normal children and adolescents. Growth, it must be recalled, is a reaction to stimuli; and the stimuli in defectives are probably deficient in some way. Here is what one might term a structural ataxia wholly homologous to the functional ataxia which is the one always obvious element in the behavior of these inefficients (aside from the moral "degenerates").

G. E. Johnson (43) indicates that in the feeble-minded the spontaneous movements, which are, of course, the most conspicuous phenomena of this class of defectives, are "of the fundamental kind and not accessory," meaning thereby that they are confined to the gross muscle-movements, primary or elementary, in all our animal life rather than to the delicate adjusting movements of personal control. Swaying of the trunk, motion of the jaw, swinging of the arm, rolling of the head, or the simplest finger-movements are among the most prominent of these fundamental movements. Moreover, says Johnson, "in the willed movements the difference between the control of the fundamental and of the accessory muscles was much more marked in the feeble-minded than in normal children. This was the more noticeable the greater the degree of idiocy. Some who could execute gross movements with regularity and control, were wholly deficient in the execution of finer movements. Even those who walked strongly were utterly devoid of the grace which results from a well-developed sense of muscular coördination and control. Nothing is more striking than the clumsy awkwardness of idiots. Sometimes where the control of the fundamental had been nearly perfected, there seemed a positive gap, as if the accessory had not developed." The proportion of finger-movements to arm-swings in the feeble-minded to those in the normal boys of like age (13.6 yrs.) was as 81 to 93.6. Here certainly is evidence that a deficiency in the conscious kinesthesia if not also in the unconscious actuating kinesthesia, is probably a factor in feeblemindedness whether the lack be central or peripheral or both.

Down (26) says: "Want of muscular coördination is the great fault of the feeble-minded."

Goddard in a personal communication to the writer says: "We have no data at all on the question of blind-folded subjects except incidentally; some of our visiting psychologists

and others have tried to do [the form-board test] blindfolded and as I remember it, their time was often as much as three minutes. I should expect that the majority of the feeble-minded would never get the blocks in place." The form-board as most of my readers doubtless know already was an invention of Seguin and as adapted by Goddard consists of a board "of wood an inch and a half thick, sixteen inches wide and twenty-two inches long, having in its upper surface ten more or less variously shaped depressions into which are loosely fitted wooden blocks of corresponding shapes [but thicker],—a circle, a square, a rectangle, triangle, star, diamond, hexagon, half-circle, and oval. The test consists in placing the blocks in their proper depressions, and the method, accuracy, and speed are all factors in the ensuing judgment of the child's mentality" (A. Holmes: 42).

Without multiplying such evidence of the aimless and ill-directed gross motivity of the feeble-minded resolved into akinesthesia, we may reasonable express the tentative opinion[4] that perhaps even the essence of feeblemindedness is some lack in the kinesthetic receptive fields or centers. These influences or stimuli continually bombard the central adjustors and so give rise to the activity which, guided and helped by the cerebral grey (biological will and intelligence and motive), results in curiosity, interest, psychophysiological evolution and education. Education is the reaction of personality to its environment; and reaction is inconceivable without kinesthesia. Certain is it that I at least can get no clear concept or understanding of the vegetative impule to activity in a complex organism, which lacks that kinesthetic deluge of energy into the reflex motor centers by which directly the voluntary muscles (whether also under vegetative dominion, or not) are actuated. In short, the 'attitude,' actuating and inhibitory, unconscious and conscious, is the creation, to a greatly predominant extent, of kinesthesia.

V. Conscious Control

Corresponding as homologue to the actuating sub-conscious or unconscious vegetative impulse to activity is personal conscious control of this activity and of the tendency thereto. How large a part the resident movement-sensations play in voluntary control of body and mind is little realized by the great world of practical educators (manual-training instructors, gymnastic teachers, school-teachers, etc.), not less than

[4] This indeed should not be hard to prove or disprove histologically by one fitted and inclined to the important research.

by the world's other army of industrial workers and employers. Some of the thoughtful psychologists,—as may be seen from the year's and last year's researches,—are awake to the pressing need of application here, application whose reward will surprise many by its size. Here lies the road which he who reads may run. That the road, however, is none too well known, even to extensive travellers along biologic highways, is illustrated in Professor Lehmann's extensive new "Grundzüge der Psychophysiologie," wherein, out of 742 pages, kinesthesia occupies less than three! But with this we are at present not further concerned. Kinesthesia is coming into its own theory, as it is sure to come into its own practice. See, for a recent example, Ioteyko and Kipiani's work (42 A and 42 B) on the ease with which children are taught kinesthetically to write and to draw; compare Montessori's general method (51 A).

H. C. Warren, for example (72), promptly recognised it as the reason for the extraordinary success (whether advisable or not!) of Doctor Maria Montessori in teaching the little children of five to write: "On account of the careful preliminary training in the motor equivalents, they form letters more accurately than the ordinary child who is merely attempting to imitate a visual copy. The words which I actually saw written by children of five and six were far more regularly formed than those of most ten or twelve-year-olds taught in the ordinary way. Moreover, the act of writing really interests the child, and he is constantly practicing it and improving his chirography." In inculcation and habit of 'motor equivalents,' underlain always by intensive kinesthetic attention, lies the undoubted short-cut to motor skill, as the writer has been preaching in a desultory way for some years. At present our concern is briefly with kinesthesia as related to the personal will proper.

It would be fatuous to rehearse the important considerations, however interesting when new, by which we have learned to regard the highly civilized and cultured adult as a product of personal (or of inherited) inhibitions or restraints of instinctive and reflex tendencies common to the more complex brutes and to savage man. Yet, few theoretical things are of more importance than this if we would truly understand the human personality. Man is man indeed only because racially and personally he has grown into the habit of inhibiting himself from brutishness or at least from savagery. Sociologically and biologically the essence of manhood is restraint,—inhibition of his impulses to untoward activity. Vegetative behavior is inherently impulsive, reflexly conative, but a *man* is char-

acteristically *an inhibitory agent with much,* complex and various, *to inhibit.* That is, in brief, the human impulse to activity is a most complicated algebraic correlation of forces or tendencies, full of new conditions to be met continually, and demanding, therefore, ever new combinations of the sensation-influences which orient him in his material and spiritual environment, and which constitute him, and thereby constitute him, man.

In general, then, conscious control, being a matter for the greater part of the cross-striated musculature, is apparently dependent on the conscious inhibitory kinesthesia, since these nerve-impulses, as we have seen, are especially related to the careful, that is, personal, adaptation to needs in skill, in grace, in every kind of efficiency dependent on adjustment as distinct from actuation. Less inadequate discussion of this phase of the feelings of movement is reserved for another paper when further experimental evidence of its importance can be offered.

VI. Notes on the Neurology of Meaning

From a largely physiological viewpoint we have, in the foregoing, described much that properly may be said to be the basis of the will. The will, however, is more than body in action, more even than the neurocircuits which control its action. Will has mental aspects as well as somatic, relations of human personality outside of matter, *meaning* as well as motion. In the results of the preceding research-work, particularly in the duality of kinesthesia's phases, there is obviously the suggestion of a contribution to the mental aspect of volition and, indirectly at least, to the euphoria-dysphoric basis of feeling.

Part of our mind's meanings are firmly related to the vegetative mechanism, hereditary and mostly subconscious, which underlies the more properly personal elements of our behavior. On the other hand, many meanings, equally efficient or more so as stimuli to action, are characteristic of the personal freer side of our common nature and may have only indirect relation to that part of ourselves that defends us, feeds us, and leads us to the getting of children. Perhaps it will seem not improper if we quote from a previous article on apraxia (18) the following hasty outline of a typically vegetative meaning, namely the meaning of space. This is an all-important meaning for humanity, as Immanuel Kant long ago expounded and many, notably Lotze, since. So far as behavior is concerned, space is, of course, one of the substantial frameworks of our experience.

As the writer has elsewhere (*Moto-Sensory Development,* 1910) in a general way suggested, observation of the development of voluntary movement in the infant during the first three years or so (a much-neglected medical field) indicates that power of deliberate action, save in the simplest innate movements of reaching and clasping with the fingers, develops *pari passu* with the conceptualization of space. This, we may not doubt, is much more than a coincidence. The infant is at first an all but reflex thing, moving under the stimulus of the inherent impulse to activity, and he becomes a free agent, personality, only as he becomes aware of the empirical three dimensions in which his body, like his wholly objective world, is constructed, and in terms of which alone initiative movement acquires meaning in any logical sense. In these terms alone to the finite mind is orientation or order: can any one, then, suppose that this universal ground of action is unrepresented in the integration of his will? * * * *

So far as spatiality is concerned (surely in its relation to deliberate movement a case in point) the " reservoir " in the young infant's brain fills from many afferent sources indeed, and they, like other complex neural conditions, are beyond present exact detailing. Because he could not draw them wholly on the map, no one doubts that New England is covered with a network of railway tracks. Among the factors of this working knowledge of spatiality, however, in the evolving infant mind and therefore mechanized in the adult, are certainly these: *A,* the resident kinesthetic influences from the limbs moving so continually under the impulse to activity, and especially those coming from the joints, muscles, tendons, skin and bones of the arms and hands, pioneers in the evocation of the deliberate will. *B,* the kinesthesia from the extrinsic eye-muscles and from such other important and widespread muscles (of the neck, back, abdomen and even legs) as assist in directing the line of sight always on the (stereoscopically placed) foveæ centrales. *C,* the kinesthetic and special impressions integrating into equilibrium and coming from the semicircular canals, the eyes, and perhaps from the protopathic receptors of the abdominal viscera. *D,* in some way as yet hard to understand, the local signs of the surface and perhaps somewhat of the interior of the body, especially of the mouth cavity. *E,* the motor mechanisms of each of the senses so far as involving adaptive or adjustive muscular movements that afford awareness of direction or of space directly, for example the tongue, the retina being a conspicuous other example on the olden-time natavistic theory of spatiality. All these and

probably other afferent influences gradually teach the baby that there is a *depth* for his deliberate exploration. A little later the kinesthesia from the locomotor mechanism, that of creeping, tumbling, walking, etc., enlarge and vigorously confirm the spatial concept thus intrinsically developed. Into the details of these various factors of original space-conception we need not even attempt to go, nor is it necessary to do so in order to be assured that their afferent impulses come from every portion of the body and directly or "symbolically" involve every portion of the brain. One need only consider how widespread is the visual "tract" through the hemisphere 'fore and 'aft; how expanded and how involved are the auditory centers if we include the essential vestibular functions; how spread-out and interknit are the taste "centers," those of smell, of touch (shown by Van Biervliet recently to be a phase of kinesthesia) and of orientation, equilibrium and local signs. Such in the sketchiest of outline only is something of the brain-neurology, it may be, of the afferent intelligence that fuses into the fast-growing infant mind as a basal working knowledge of the space in which alone he can move and so have his being.

In proportion as the individual intimately knows this space as represented to him thus by the nervous system is he capable and skillful and efficient, master of himself and of his plastic environment. In short, in the neural (and muscular) mechanism that develops originally a personality's notion of space we appear to have the foundation more or less of the neuromuscular mechanism of voluntary movement in its most obvious details and framework both at once, and what develops in the infant becomes the (often subconscious) determinant of the behavior of the adult.

Let this be taken only as an example of a whole group of meanings in which body and mind exhibit, both subjectively and objectively, their inherent unification in some transcendental mode that we cannot understand.

Obviously kinesthesis is the chief immediate means to our percept and our concept of spatiality.

Another whole important range of meanings, namely those of the emotional sort, have their ground more or less frankly in the kinesthetic and coenesthetic influences (the latter being largely kinesthetic). Exposition of these meanings would furnish material for interesting monographs in plenty; and few topics in the relation of body and mind would render more profit of practical scientific and educational use. Mind has a motor basis, and nowhere else is the direct connection of

kinesthesia (actuating and inhibitory) and significance more clearly to be seen than in the affects. Graphic and plastic artistry amply show this motor ground, as all who are familiar with physiological esthetics clearly recognise. It is music, however, the freest of them all, in which the kinesthetic factor is most apparent. Of course, the over-evolved music of the ultra-'classic' kind, more intellectualism than feeling, exhibits this basis less clearly than does real music, the purely affective musical music of the opera, the ball-room, and the battle-field, intended for enjoyment or for use rather than for a bastard instruction in artificial technique. In the experience of this real kind of music, conscious kinesthesia is altogether dominant, and provides the psychological framework of this stirring mode of experience. This domination of the rhythm-aspect of music (and rhythm, I take it, is wholly and inherently kinesthetic and coenesthetic) has generally been recognised, but in my opinion always inadequately, as, for example, even by the latest writer on the subject, Weld (73). Lack of space makes inexpedient the elaboration of this important relation here. In general, it is to be observed that the vibrations that form important parts of many kinds of experience, and which are perceived, of course, wholly kinestically, have so far failed to receive the attention they deserve at the hands of psycho-physiologists. Helen Kellar (44) has some extremely pertinent and interesting remarks anent this theme; and what to her is clear consciousness we may be sure is at least subconsciously but none the less *effective* in every one of us.

How unifiedly intimate the receptor impulses are in such examples as we have suggested on the one hand to bodily movement and on the other, logically quite different, to our consciousness, is apparent almost at once. Without kinesthesia, space is a meaning clearly unintelligible; and music based on rhythm is well-nigh inconceivable. Wundt's principle of 'creative resultants' has long been the model for explanations of meanings similar to these. They who refuse to admit the efficiency of this method[5] must be surviving believers in that narrow notion of mind that limits it to immediate awareness, ignoring the vast complex deeps of 'the subconscious.' Numberless meanings have been synthesized out of the primary sense-experiences (attitudes) in every normal child's brain and mind and the neurility representing them in the adult has long since sunken out of consciousness, save as intensive (more or less inhibitory) effort in skill or other new and personal

[5] For instance, Wm. McDougall (50) in his brief clear argument, "The Psycho-physics of 'Meaning.'"

deliberate effort floats them to and on the conscious surface of the stream of mental action.

Just as every intended voluntary movement depends for its integration and realization on the implicit spatial frame-work of kinesthetic, visual, auditory, etc., neurility, kinetic or potential in the central nervous system, so every bit of understanding that helps constitute our minds or serve as a basis of volition, has its basis, mediately or immediately, in the two-phased innervation of the vegetative and the personal will. The far-reaching practical value of this understanding, of these meanings, may be exemplified in the use of objects (eupraxia), material or otherwise. Each object, in so far as deliberately made by sane man, has a meaning, namely, of course, its final purpose or use. This use, in general, is not understood as a real understanding save as the individual actually uses the object. Of course, this information may be and often is obtained at second-hand, as one learns from books instead of by first-hand observation; but we have to suppose the brain-paths concerned to be the same substantially in both cases—namely, the grey fabric of the hemispheres in its entirety or in part.

The *early elaboration of human behavior into very numerous psychomotor complexes* on a basis of economy and habit devolves especially, we may reasonably presume, on two important portions of the brain (connected intimately, however with all the rest)—the frontal lobes (via the central) and the cerebellum. If we know anything at all of the frontal cortex it is that one, at least, of its duties is this elaboration of motor ideas, how to use objects, for example, or how to rotate the arm or roll a shot between the fingers. These centers have in early years elaborated many such psychomotor complexes, have interrelated them, and have put them in bewildering intimacy with all the other centers in the brain and below it. Broca's convolution furnishes what is probably by far the most complex example of an eupraxic center, and its function is just the elaboration, interrelation, and extra-relation of a certain set of objects, namely, words. These, spoken, written, printed, graven, depicted, sculptured or materialized by the sign-manual constitute the physical basis, so to say, of the one uniquely human process of language-formation and language-expression. Need one try to imagine the details of Max Mueller's speech-center in terms of neur-axones, dendrites, nerve-cells, or of ions and osmosis and reversing colloids? Yet this must be done some time and by some one or else all our fashionable localization be given up.

In a way quite homologous to this, every common object

other than words must have representation in the frontal cortex, we may assume. If, then, a man does not know how to use a sextant or an ediograph or a planimeter, or a pencil or a pair of shears, it is so only because his frontal cortex has never acquired or, from disease, has lost that particular psychomotor complex. No more can be taken out than has been put in. As has been often well pointed out, the newborn child is almost wholly apraxic, although even then something in his mechanism of efficiency represents the use of his mother's breast just as it represents and provides the means of finding it in space. The cleverest adult obviously is he who has in his frontal cortex the greatest number and the greatest perfection of detail and relationship of these motor ideas (neurograms) of movements of utility.

Each one of these is properly a meaning and there is no reason whatever to suppose that each one could not be fully accounted for in neurogramic terms if we knew the exact itinerary of every forceful impulse concerned in setting them into the mental process. Proof of the falsity of this supposition is part of the burden imposed upon those who doubt it, for it is the *natural* supposition, rational in every phase of psycho-physiology. Those who doubt it simply fail to imagine the complexity of the human brain as a working machine, or the possible combinations and interactions of its three or four thousand million neurones.

President Sanford in a recent suggestive essay (62) makes explicit certain phases (the mathematical in particular) of meaning in relation to kinesthesia; and even while his arguments strive to show the limitations of sensation in this respect, they lend us distinct aid and comfort when they are properly oriented. "The concepts of physics," he says, "tend, in a word, to state all physical phenomena in terms ultimately reducible to dermal and kinesthetic experiences, and by that very fact physics is prevented from explaining anything that lies outside the field of dermal and kinesthetic experiences because of the impossibility of translating one sort of sensation into another sort. * * * * [Yet,] we can in some cases indeed transfer meanings and use symbols derived from one sense as carriers for meanings derived from another sense, as for example, when we treat geometrical relations by algebraical symbols in analytical geometry. But this is merely a transfer of the language signs, *i. e.*, of the signs of symbols, and not of the original symbols themselves. In every case the meaning must come from somewhere (*i. e.*, ultimately from some sensory experience) and the meaning then gives limits

to the symbols as if they had originated along with it." But the present writer would respectfully inquire of President Sanford (and of Wm. McDougall) if one of the most basal and universal processes of psycho-neural life be not just this particular process of 'transfer' unlimited and fusion. Normally,—that is naturally—no one sense ever is active alone, as indeed many recent researches,—*inter alia,* those of Sewall (63), Head and Holmes (38), Head and Sherren (37), Crile (12),—have testified designedly or by implication. Functional integration is all but universal. Here is suggested one of the five or six respects in which descriptive analysis has gone so far as plainly to mislead, implying a simplicity which in fact in no wise exists. The "transfer of language signs, 'only' signs of symbols" though they be, is certainly all that one need postulate for 'explaining' the elaboration of much in the way of meanings and value out of 'simple' kinesthetic and tactile experiences. Half of what the reader knows and more has come into his soul by just this process of transfer and fusion and symbolism in his brain.

But hear Doctor Sanford again about the internal kinesthesia of the body called by another name of "general and organic sensations:" "And yet even touch itself [kinesthesia] furnishes but the outer and less important part of our empirical selves. A deeper self is the self of feeling and emotion, the self that loves and hates, that strives and aspires, that enjoys and suffers, and for this another group of senses is chiefly responsible—that inner group of general or organic sensations. It is of the reverberations of excitations within the field of these inner senses that the moving part of our emotions is constituted. The loss of feeling robs us of all that part of ourselves that makes life or anything else valuable [a word of wisdom the school ma'ms need to learn]. And that part of ourselves we owe chiefly to our general and organic sensations. To sum up briefly, I may say that we get from the chief senses, singly or in coöperation, four characteristically different abstractions: From touch [kinesthesia] we get the world of space and material reality, and force acting upon us; also, from motor touch, energy, active efficiency, and freedom; from vision we get space and the world of things, though in a somewhat different way from that in which touch gives them to us; from hearing we get our symbolic machinery of thought; from the general and organic senses, our most intimate intuitions of ourselves and the basis of our emotions." Clearly there's ample room here for all one, even a partisan, need claim at present for kinesthesia

in its relation with the intelligent will:—space, material reality, force, energy, active efficiency, freedom, and "all that part of ourselves that makes life or anything else valuable." And patient research will demonstrate to the most dogmatic 'animist' (for animists all have bodies too) sooner or later the pathways, the currents, the tidal-chart, so to speak, of the neurility by which all these experiences are represented in our mortal days.

About the logical limit of present seeming aloofness from obvious nervous impulses along named tracts and nerves, is exemplified in numberless abstract concepts of relation tinged with emotional tone. All other mental processes are relatively, always relatively, simple. But even here the kinesthetic influences come more directly into the exploit than the average psychologist as yet realizes. Merely to point out the road sometimes is an acceptable service, even if we stay behind.

Wm. McDougall cogently states and trenchantly discusses a case (the telegram-argument) which may, perhaps, usefully be taken as an instance of average complexity and of more than average interest,—as one would expect from the "hands" of the Oxford psychologist for whom psychology is "the positive science of the behavior of living things." Let us quote the situation (50): "A man receives from a friend a telegram saying—'Your son is dead.' The physical agent to which the man reacts is a series of black marks on a piece of paper. The action outwardly considered as a series of bodily processes, consists, perhaps, of a sudden, total and final, cessation of all those activities that constitute the outward signs of life; or in the complete change of the whole course of the man's behavior throughout the rest of his life. And all this altered course of life, beginning, perhaps, with a series of activities that is completely novel and unprecedented in the course of his life, bears no direct relation whatever to the nature of the physical stimulus. The independence of the reaction on the nature of the physical impression is well brought out by the reflexion that the omission of a single letter, namely, the first of the series (converting the statement into 'Our son is dead') would have determined none of this long train of bodily effects, but merely the writing of a letter of condolence or the utterance of a conventional expression of regret; whereas if the telegram had been written in any one of a dozen foreign languages known to the recipient, or if the same meaning had been conveyed to him by means of a series of auditory impressions or by any one of many different possible means of communication, the resulting behavior

would have been the same in all cases in spite of the great differences between the series of sense-impressions." The constant meaning behind all these extraneous conditions McDougall supposes to constitute "the essential link in each case between the series of physical impressions and the series of physical effects." He denies absolutely any evidence that such spiritual values of meaning as that conveyed by certain little curved lines of ink on the telegram-blank can be expressed at all in neural terms.

Yet, on page 342 of the same interesting argument for 'animism' we read a paragraph that seems to imply answer to previous doubts. "We have, then, very strong grounds for maintaining that all mental retention and reproduction are conditioned in two very different ways; one of these ways, the way of motor habit and automatism and mechanical association, is adequately accounted for by the conception of the formation of neural associations by the repeated passage of the current of nervous energy between neuron and neuron, each passage leaving the track more open for subsequent passages. (Synaptic resistances lowered?) This is the only plausible and in fact seems to be the only possible conception of the way in which mental retention can be conditioned by cerebral structure or function; but the strict limitations of this mode of retention, especially the need of many repetitions of the impressions even in very simple instances of mechanical association, show that we cannot regard it as the sole or principle condition of the higher form of retention or true memory. This we see depends upon meaning; and meaning as we have seen, is just that all-important factor in mental process to which we can assign no immediate physical correlate among the brain processes,"

It is the expression "the strict limitations of this mode of retention" to which almost anyone who was really searching for concomitant somatic conditions (instead of afraid he would find them?) would naturally object. Logically it wholly begs the question and neurologically it limits knowledge and scientific explanation and presumption somewhere near the *beginning* of the nexus between psychosis and neurosis. The present writer might reasonably be classed as an 'animist' by one who affected this particular class-name, yet he certainly hopes to see started, at least, description of the homologue of every mental process in bodily terms and that without the doctrinal exclusion of any amount of interaction between the two empirical series. This seems the easy road, identified for

once with " the straight and narrow way," by which the idealist may expect scientific (psychological) satisfaction.

Memory and habit-formation and meaning symbolized to the mind by material symbols, are facts as obvious and certain as the Cartesian ' cogito.' The symbolic method of representation in the hemispherical grey is put beyond hypothesis by the cold facts of apraxia, etc., already suggested; and at once underlying and surmounting these are the neurograms, less known but certain, representing impulse, feeling, desires, character, motives of the most basal nature, broad and deep and long as humanhood itself. Combined, these three factors seem to the writer to suggest the method, at least, of the concomitance of meaning. If the kinesthetic and retinal impressions from that grievous telegram do not in the artificially strict terms of the physiological laboratory, appear as mechanic stimuli of a life-time of asthenia and misery, at any rate of change, it is assuredly because once more, as forever yet, the *complexity* of the problem is underestimated, almost overlooked,—even by the learned Oxford reader in philosophy! One seeks too much from a little given, demanding bricks to build cathedrals to the skies without the utterly indispensable straw! The defect in our psychophysiology, in other words, is quantitative and not qualitative.

It is time the traditional notion of ' traces ' ' impressed in ' the brain by experience immediate or otherwise were given up out of psychophysiology for good and all. Nothing at all is gained by retaining this neo-phrenological idol of the school, while on the contrary it is a cogent example of how much the antiquated make-shift concept prevents us from advancing. There *are* no ' traces ' on the brain-tissue so far as anyone has been able to learn. Memory, habit, understanding, feeling, meaning, and the rest are not dependent on any kind of ' grooves ' made in the living grey fabric of the great hemispheres. Eighty-five per cent of water is this intricate layer of cells and dendrites that we call the cortex; and the ceaseless activity and change, its hurrying life, exceeds that of every other portion of the organism.

But if not as material traces or vestigia how, then, can we think the mode of retention and fusion and interaction by which alone perception, imagination, conception, reason, meaning, and allied processes are thinkable facts at all? Assuredly we shall accept the alternative (it seems to the writer the exclusive alternative in view of the facts known to him) namely, of course, the conception of active kinetic strains and stresses in the " three or four thousand millions " of neurones

making up the brain. Floods of neural influence of many kinds along the separate conducting pathways, infinite variations and relations of tonus in the nerve-cells of these neurones!

And pray why not? And let Wm. McDougall and all others who could be human disembodied, tell us why there is not here sanction in plenty for every phase of intelligence, vegetative or personal, brute or human, the crudest matters of gross fact or the most subtle shades of feeling and of meaning, momentary and individual in its influence or affecting myriads of other men in *secula seculorum.* Here is *living energy,* energy in the one thing the most complicated of all things known to the human mind, so complex that it furnishes a thoroughly rational basis for even the filmy gossamers (in Huxley's famous phrase) of the soul's experience. Why refuse to a mechanism of this description,—nay, intricate beyond all present description or imagining,—any meaning however sad or overwhelming, however far and wide from the material symbols, 'stimuli,' on the paper page? What are these symbols but cues, but keys, into this marvellous maze? What matter how simple the stimuli—does not the wondrous labyrinth of living energy with its billions of pathways remain the same, and in combination, in *living,* far in excess of every finite dream—rich in possibilities beyond the dreams of even animistic avarice?

I, for one, know no complexity in mind for which an organism so integrated is not the homologue and peer.

This maze of living energy is kinetically the direct *continuum,* for the most part, of the kinesthetic flood of influences. We get here, perhaps, a-field from the definite kinesthetic pathways technically so described by the histological neurologists; but we certainly do not at all get beyond the possibility of representing psychophysic motives in terms of energy or the somatic influences in terms of motives—whichever way one prefers it stated. Implicated in every moment of the behavior of that miserable father, whether statable as actuative or inhibitory, were kinetic (or potential?) nerve-strains representing the mediate or immediate variations in some action-system (if we include therein the epithelia). Attitudes are but crystallized kinetic kinesthesiograms (if such a term be not uncoinable?). And certainly his behavior, as a series of conscious and subconscious motives actualized, was the immediate outcome continuously of attitudes whose tenor was fixed " infinite aeons ere our race began " in the instinct of complex parental love and care.

Strangely enough, some of McDougall's own theory, adopted by many and suggested (probably quite unknown to McDougall) by Claparède (11) eight years ago, helps materially in the acceptance of the full value of kinesthesia in concomitance. His theory of fatigue (49) seems to contain a point of view at least (it is probably much more—a physiological reality in some mode or other) which, made a bit intensive, would more or less belie the notions as related above of the same McDougall self-deemed an animist. This viewpoint overlooks his reservoir-idea of the central nervous system already used above, a fertile concept on which to base a theory of motivation in the terms of nervous circuits already suggested. The name reservoir-idea is all but self-explanatory; it assumes (more or less after Sherrington, Bastian, *et al.*) that the afferent or receptor side of the nervous system plus the central adjustor influences, constitute properly a reservoir of neurility on which the efferent, effector pathways and mechanisms draw one at a time (the efferent common paths of Sherrington (64)). The whole trend of kinesthesiology conducts the same way and each helps the other. Carrying this idea only a step or two further in an entirely justifiable, yes, necessary direction, we may suppose the neuronal knots, grey matter, everywhere, in the sympathetic ganglia and the cord as well as in the brain, to be surcharged with nervous tension, potential or kinetic energy, 'awaiting' only a chance to functionally discharge. Its function would cause it to discharge quite as much, perhaps, in feeling and in temperamental matters, quite as commonly or at least as normally, into cerebral mazes standing for early-acquired complexes of affective or cognitive *meanings* as into attentive consciousness seen as voluntary movement new in every case or in the habitual reflex aspects of attention-behavior (13).

Normally the actual activities of the real man or woman are arranged in well-defined functional groups. This is clearly necessary owing to the almost universal principle of habituation. These habit-groups of contractile and secretory activities are not so much muscular and epithelial groups or complexes as they are neural, for it is, of course, just the one sole business of the nervous system to bring about this very kind of adapted integration of unitary movements into activities such as make up the actual functions, just as these combined and unified in turn are an individual life. We have not far to seek nowadays in the anatomic arrangement of nervous system to find the structural basis of this habit-grouping of muscular and glandular actions. One order of them we find

based in the almost innumerable association-complexes of the brain and spinal cord; these are the so-called "higher" functions and are concerned immediately with the freer or voluntary activities. The other order of action-complexes are basally of the vegetative kind, are more or less reflexly (that is, mechanically or chemically) determined, and have their basis in the numerous ganglia and other functional groupings of the "autonomic nerves" (a necessary new name for the familiar sympathetic plus certain other similar nerves concerned with the alimentary canal). One sees in the sympathetic groups of ganglia, some of them arranged along the sides of the spinal cord; others (for example the solar plexus) huge orderly knots of protean neurones in the abdominal cavity; while still other are scattered in large numbers, but functionally related, in the various viscera of the thorax and abdomen. As is well known, it is almost the entire duty of these ganglia and of the fibers relating them, to direct the activities of the involuntary ("smooth") muscle and of the epithelium, whatever be the precise functions of the particular muscles or glands. This functional set of nerves is intimately related, in ways too complex to be here described, with the cerebro-spinal axis of nerve-paths. Moreover, it represents not only the movements but probably the normally ill-defined sensations of the tissues it supplies.

Now, because these unit-complexes of the vegetative functions of life (nutritional, circulatory, reproductive, etc.) represent the real biologic basis of the nature of the individual, we have to think of them as forming to a considerable extent the *fundamental somatic character of the man or woman as determining his or her biologic, phylogenic interests.* Thus, for example, the man with an abnormally capacious and habitually overburdened alimentary canal, that of the glutton, will have these visceral characters in some way represented in the habit-complexes of his sympathetic ganglia; in the sympathetic of the nymphomaniac the same conditions, properly adapted, must be present; and so on in all the organic systems. The unit-complexes especially of the sympathetic represent then, in some way, without a question, the basal vegetative peculiarities of the individual. It is these obviously that determine more than all else the biologic and phylenic interests and tendencies and meanings of every person as a social unit, as a link in the chain of the generations. August Hoch in a discussion of dementia precox before the American Neurological Society, succinctly stated the same group-action

of the nervous system and added another principle germane to the neurility of meaning, thus (39):

"Our memories are grouped, as it were, in more or less extensive and more or less circumscribed complexes or centers of attraction, in the formation and cohesion of which special interests take an important part. We can conceive of the mind, therefore, as made up essentially of trends of interest. In the course of individual development certain main tendencies of the personality develop which then take the lead, while other tendencies become repressed. These repressed trends exert nevertheless a marked influence on the conscious thought and activity, as Freud has shown; but in normal life they do so mainly through the fact that the energy they supply is led into profitable channels. Every trend naturally pushes toward a realization in the direction of its feelings. If this is in harmony with the main tendencies of the personality this is useful and represents the dynamic force behind our thinking and our pursuits, adapted to the environment and the given situation. If, however, trends which are not in harmony with the main tendencies of the personality and which are, therefore, under the influences of repression, no longer find an outlet in profitable channels, but assume a more or less independent dominating rôle, it is not to be supposed that the laws which govern normal mental activity should be suspended; on the contrary, we shall expect to find the same principle of the trend pushing toward its realization, while at the same time the other tendencies of the personality assert themselves in repressing influences as well as in adjustment reactions, but owing to the disturbance of balance between the usurping trend and the main tendencies of the personality, the thinking and acting is then no longer adapted to the actual situation, but appears as something strikingly out of contact with it, and is of a simpler, more crude type."

In a somewhat like way Morton Prince (58) recently has said, "Meaning is derived from and determined by past experiences. That is to say, ideas have associative relations to objects, thoughts, actions, conduct, stimuli, constellated ideas, etc., *i. e.*, past experiences represented by conserved complexes. As a result of such previous experiences various associations are built up and these complexes form the setting or context which gives ideas meaning." "In the building of complexes [*e. g.*, meanings] as we have seen, an affect becomes linked to an idea through an emotional experience. * * * * Now we must distinguish between the process which determines the

meaning of the idea and the process which determines the presence of the affect in consciousness. * * * * That which determines the meaning is, as we have seen, the setting which provides the secondary images and the associated ideas, and, therefore, the point of view. That which determines the affect is an association or linking of the whole affective mechanism (including the physiological reactions, *i. e.,* vasomotor, respiratory, secretory phenomena, etc.) to an idea. It does not give the meaning, but provides the impulsive force which tends to carry the idea to fruition. * * * * It is not a logical necessity that the original experience which occasioned the affect should always be postulated as a continuing unconscious prcoess to account for the affect in association with the idea. It is quite possible, if not extremely probable, that in the simpler types, at least, of the emotional complexes, the association between the idea and affect becomes so firmly established that the conscious idea alone without the coöperation of an unconscious process is sufficient to awake the emotion."

This application of Pavlov's discoveries is beyond cavil still more likely to work backwards, for it's a poor rule indeed that will not work both ways. Even an unconscious (actuating) kinesthetic influence coming into the " set " of the brain is readily competent to awaken a conscious idea, colored by whatever affect phylogeny and personal habit have rendered it in that particular individual. This complex serves, then, indefinitely as a motive of behavior.

Our present research into the phases of the movement-' sensations ' adds a little, it may be, to this promising way of considering the nervous system's kinetic thrust, for it suggests that the duality of phase (actuating and inhibitory) found to obtain in kinesthesia proper, may be extended into the brain's grey fabric, and thereby underlie the determination of behavior —conation in its widest inclusion. Not by physiological chance, we may be sure, was the awful meaning of that well-supposed telegram asthenic and depressing to the total behavior, as a psycho-physical series, of the father, for the written symbols on the paper formed a well-established kinetic nexus with everything in his grey cortex and below bearing him thus downward. On the other hand, had the symbols meant, " You are a grandfather: ten-pound boy named for you; all well," these too would have fitted into a nexus, of the opposite tenor and effect, sthenic and stimulating, but an integration complete in itself as represented in the phylogenic and ontogenic fabric of his kinetic nature. It is not easy for the writer to understand why McDougall should venture

(deductively?) to set a perfectly arbitrary limit to the concomitance of his neurons and refuse them a share in meaning when the continuity in all respects and everywhere is so complete. Why should one require a wholly gratuitous insert ("products in consciousness of a purely psychic activity") at one particular place in a series seen to be complete without it as soon as we know our anatomy and especially our neurophysiology better than now? I have no doubt of the "products in consciousness of a purely psychic activity," but I believe them irrelevant in a series competent without them, however unified the two series be. The very essence of brain-action is synthesis and symbolism endlessly subtle and intricate, as McDougall's explicity of the reservoir-idea indeed implies. Animism *needs* no denial of the brain's subtlety and intricacy—it rests on too firm a basis and is itself too broad to require a shoring up by any destructive criticism of a series in itself utterly beyond, in its intricacy, man's present comprehension. The law of parsimony, if nothing better, would suggest the superfluity of this particular instance of interaction.

The two neural factors underlying human behavior, then, seem to be tentatively considerable as two-phased, on one hand a set of action-influences or attitudes (more or less directly related to the total compound innervation of the action-system in use at the time, and including kinesthesia proper, touch, vision, and hearing), and on the other hand, a set of kinetic fusions, involving probably in some measure of influence the whole central nervous system. These latter more especially perhaps constitute the meaning of the experience, relatively passive or active, its intent, its personal motive or purpose, all meaning being sooner or later reducible to motivation, kinetic or potential. The former, the action-set proper, is the more or less subconscious association between the more mechanical neurones of the nervous system, sympathetic, spinal, cerebellar, and cerebral. The latter (the personal, purposive, restrictive control-influences, including the resultant of the feeling-tone and of the conation proper) constitutes, in my opinion, the more conscious meaning of the organic motion represented, however remotely. Meaning as feeling plus conation plus expression-innervations, seems to underlie both the kinesthetic phases disclosed in the research, but is conscious meaning only in the inhibitory motor ideas of the implicated behavior. The meaning of that sad telegram to the father, for example, was represented in his kinetic neurograms (sympathetic, spinal, cerebral) as certain definite modes of behavior. Meaning seems irrational save on this pragmatic

motor basis, involving immediately or remotely, by the way of the neurones organic " expression " or its negation.

The majority of psychologists perhaps would suppose the correlates of meanings to be vague ' drainage '-flows between groups of central neurones acting on principals still much in debate. But whatever be the cerebral harmony of subtle action, the motive force for this meaningful " association " or fusion-process, with its " high synaptic resistances," etc., etc., is not at all apparent save on lines somewhat like those sketched above. With these tentative principles and facts in mind we shall think of meaning-fusions as a more or less direct functional continuation of the kinesthetic (*et al.*) influences flooding even the central nervous system from the action-system—the entire musculature voluntary and vegetative, and the nervous centers. The immediate meaning-innervations have, of course, an immediate independence of the current flood of kinesthetic influences, but just how much or for how long we do not as yet know. Nor do we need to know this exactly so long as we realize that the energy just behind the meaning (if we may so speak, metaphorically) comes from the muscular chemism by way of kinetic energy in muscle and nerve-cell and floods the brain with a living " head " of motivation force. The body's action as a whole, universal as tonus and more patently, keeps the great coördination-tracts tingling with uncountable thousands of kinetic impulses primarily kinesthetic.

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